

Layers in Time

Grand Canyon Geology Distance Learning Program

Pre-program lesson: Complete the following “Build-a-Grand Canyon” activity prior to the distance learning program.

Grand Canyon Focus: Geology
School Subjects: Earth Science
Grade Level: 4-8
Time requirement: One or two class periods. (60-90 minutes)

National Standards Addressed in the pre-lesson: (See list at end of lesson plan for details)

Science K-4:

A-Science as Inquiry

A.1 Abilities necessary to do scientific inquiry

D- Earth and Space Science

D.1 Properties of earth materials
D.3 Changes in earth and sky

Social Studies- Geography K-12

The World in Spatial Terms

Common Core Standards addressed in the pre-lesson:

Literacy in Science and Technical Subjects

Lesson Overview

Earth has been shaped by time, gravity and the processes of deposition, uplift and erosion. Grand Canyon serves as an outstanding geologic classroom and through study of this amazing landscape, students gain a better understanding of these universal geologic principles and processes.

Lesson Objectives: Students will be able to:

- 1) Describe the basic geologic processes responsible for forming Grand Canyon.
- 2) List three major rock families.
- 3) Give examples of environmental changes over geologic time.
- 4) Recognize the vastness of geologic time represented by Grand Canyon’s rock layers.

Materials

Go to: <http://www.nps.gov/grca/forteachers/learning/layers-in-time.htm> for the first two materials listed.

- *Layers in Time* article (1 per child or group)
- Paleozoic environment posters (optional)
- White poster paper (one piece approximately 8” x 36” per team)
- Markers, paints and other art supplies for drawing and coloring

Background Information

Grand Canyon is famous for the beauty of the many rock layers exposed and for the stories they tell. Scientists from all over the world come to study the rocks. Although there is a consensus about the age of the layers and how they formed, there are still mysteries around the specifics of how the canyon itself was formed. The Colorado River carved it, but how the river got there and began the process remains poorly understood, and is still actively studied and debated.

The oldest rock, which is 1.8 billion years old, is found near the river at the bottom of the canyon. This metamorphic rock was formed by heat and pressure, and is the eroded remains of an ancient mountain range. Shortly after this rock formed, magma from far below the earth's surface flowed into the weakest parts, or fractures, of the metamorphic rock where it then cooled and hardened. This granite, a type of igneous rock, is visible as pinkish and white veins in the metamorphic rock at the bottom of the canyon.

Most of the rock visible at Grand Canyon is sedimentary; made up of sand, mud, silt and other sediments laid down over long periods of time by rivers, streams, seas and wind. Through time, layer upon layer deposited on top of another; compacting and cementing these once soft sediments into the rocks exposed today! These sedimentary rocks range from 550 million years old to 270 million years old. Fossil remains of plants and animals in these rocks help provide clues to environments in which these rocks formed.

After the rock layers formed, the next critical part of the process involved uplift of the Colorado Plateau. Plate tectonics is responsible for this uplift, most of which occurred 40 – 80 million years ago as the North American and Pacific plates were colliding. This uplift caused rocks that were deposited below sea level to be raised up thousands of feet above sea level in the Grand Canyon region. This process was critical to the eventual formation of Grand Canyon, and set the stage for the final chapter in the formation of Grand Canyon.

The canyon was formed as the Colorado River cut through these uplifted rock layers in the process called erosion. In addition to the river, other forces of erosion such as rain, snowmelt, and small creeks and streams from side canyons also cause the Grand Canyon to become wider and deeper. The weaker layers erode creating slopes whereas the strong layers form cliffs, giving Grand Canyon its recognizable staircase landscape. The rocks at the canyon are ancient but the landscape itself is young. The Colorado River started carving the Grand Canyon 5-6 million years ago, which from a geologic perspective is a blink of the eye.

Procedure

1. Break the students into five groups. Assign each team one of the following rock layers to research (make sure the students understand that these five layers are only a sampling of the dozens of major rock layers within Grand Canyon).

- Precambrian Basement Rocks (Vishnu Schist & Zoroaster Granite)
- Bright Angel Shale
- Hermit Shale
- Coconino Sandstone
- Kaibab Limestone

2. The student groups can use the *Layers in Time* article to do research on these layers to answer the following questions:

- 1) How old is the layer?
- 2) What type of rock is it? (Sedimentary, igneous, metamorphic)
- 3) What environment was present when this rock was deposited?
- 4) Are there any fossils associated with the layer? If so, list some of them.

An excellent source of information on the rock layers of Grand Canyon can be found at the National Park Service's VIEWS website at:

<<http://www.nature.nps.gov/views/layouts/Main.html#/GRCA/geo/dep/>>

Once there, click on the "Stratigraphy" tab.

3. After doing the research and answering the above questions, the teams will portray their layer on the 8" x 36" piece of paper. They can draw and color the layer and include some of the organisms fossilized in the layer, or clip images of today's environments and attach them to the sheet. Encourage them to

use their imagination. If they are having problems with this activity, consider showing them the Paleozoic environment posters, found as a PDF, at:

<http://www.nps.gov/grca/forteachers/learning/layers-in-time.htm>

4. Encourage your students to create a list of questions prior to the distance learning program. They will have the opportunity to present these questions to the Park Rangers during the last five to ten minutes of the program. Please guide your students in writing thoughtful questions.

DURING THE DISTANCE LEARNING PROGRAM

Materials needed during the program with the rangers:

- Rock layer posters made by students during the “Build-a-Grand Canyon” activity.
- Two triangular shaped pieces of paper to illustrate canyon carving. One measuring about 8” long, and 4” wide at top tapering down to a point. The second about 3 feet long, 16” wide at top tapering down to a point.).
- Easel, blackboard or open wall space visible to the rangers during the distance learning program.
- Tape or other items needed to attach the rock layers to the easel, wall or blackboard
- A spray bottle of water

Procedure

The rangers will begin by reviewing the basic processes responsible for Grand Canyon formation, which are described in the “Background Information” above.

A) The first part of the story is getting the rock deposited. This activity will reinforce the process of deposition.

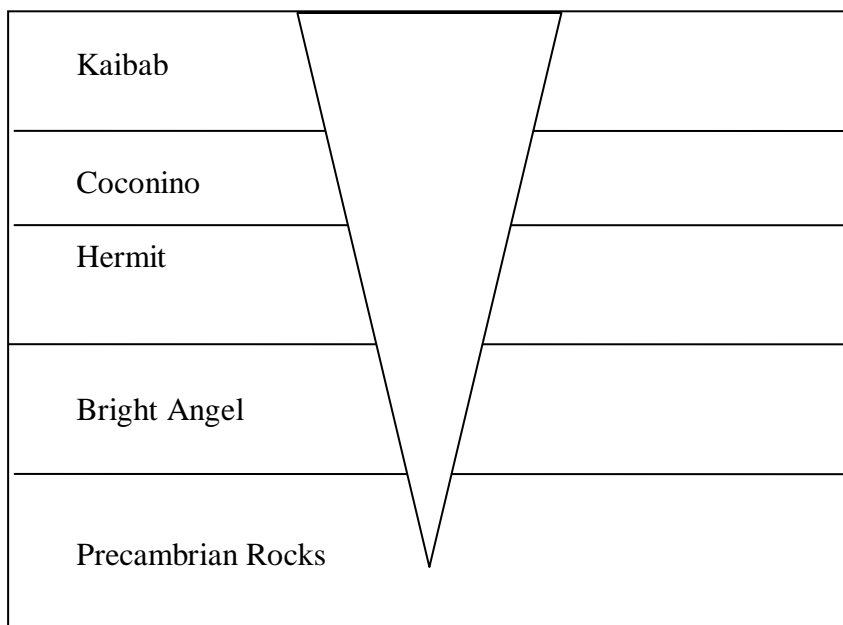
The rangers will ask the team with the oldest rock layer to come up first and tape their layer to the easel, wall or blackboard. The group will then tell the rest of their class the information they learned about their layer (age, type, environment, fossils.) This process will continue until the last layer is “deposited.” (See figure 1)

Figure 1

Kaibab
Coconino
Hermit
Bright Angel
Precambrian Basement Rocks (Vishnu Schist & Zoroaster Granite)

B) The second part of the story is uplift, which will be covered with short interactive activities (Thumbnail plate tectonics, student “mountain building”).

C) The last part focuses on erosion. The ranger will ask the students to close their eyes so that their teacher can “hit” them with the incredibly powerful force responsible for carving the Grand Canyon. Once their eyes are closed, the teacher can begin squirting the students with water. The ranger will review the process of canyon cutting and the teacher can add the large triangular piece of paper to the center of layers of rock representing the river cutting the rocks to form the canyon.



Extension Activities:

1) To help students get a better understanding of geologic time, you can download the Geology Lesson Plans at: <http://www.nps.gov/grca/forteachers/classrooms/geology-lesson-plans.htm> and use the Grand Canyon geologic timeline activity found on page 17. Print the “Grand Canyon Geologic Timeline” activity in the Geology Lesson Plans link, and print out the Geologic Timeline Cards (which is a link just below the Geology Lesson Plans).

2) Connect the geologic stories to the student’s back yard. Once the students have researched their layer of Grand Canyon, have them identify what was happening in their geologic backyard during the same time period. What did your state or town look like 500 million years ago (mya), 300 mya, 100 mya, and 50 mya? Have them chart their home state geologic history. Was there an ocean, swamp, desert or forest over their home at one time, and if so, when? What fossils are found in their state? What are the most common types of rocks found in their neighborhood? When were the nearby mountains or hills formed? Do they have a canyon nearby or other signs of erosion?

Resources:

- “An Introduction to Grand Canyon Geology”, a book published by the Grand Canyon Association. It is available for purchase on the GCA website at: <www.grandcanyon.org>.
- Grand Canyon National Park website: <www.nps.gov/grca>.
- Grand Canyon National Park VIEWS website:
<http://www.nature.nps.gov/views/layouts/Main.html#/GRCA/geo/dep/>

National Teaching Standards Addressed

The “Layers in Time” program addresses the following National Teaching Standards:

Science K-4

NS.K-4.2 Physical Science

Properties of objects and materials

NS.K-4.3 Life Science

Organisms and environments

NS.K-4.4 Earth and Space Science

Properties of earth materials

Changes in earth and sky

Science 5-8

NS.5-8.3 Life Science

Diversity and adaptations of organisms

NS.5-8.4 Earth and Space Science

Structure of the earth system

Earth's history

Social Studies- Geography K-12

NSS-G.K-12.1 The World in Spatial Terms

Understand how to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

NSS-G.K-12.3 Physical Systems

Understand the physical processes that shape the patterns of Earth's surface.

Common Core Standards

Literacy in Science and Technical Subjects

RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics*.

RST.6-8.10. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.

*Although our programs address the curriculum standards, it remains the responsibility of the individual teacher to determine the extent to which the standards have been met based on program content, pre- and post-visit activities, and appropriate evaluation of student learning and understanding.

*Last updated August 2013